KHNPDCDRAIsPEm Resource

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Sent: Tuesday, June 23, 2015 9:18 AM
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Subject: APR1400 Design Certification Application RAI 48-7943 (04.03 - Nuclear Design)
Attachments: APR1400 DC RAI 48 SRSB 7943.pdf; image001.jpg

KHNP

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs.

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

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REQUEST FOR ADDITIONAL INFORMATION 48-7943

Issue Date: 06/23/2015
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 04.03 - Nuclear Design
Application Section:

QUESTIONS

04.03-2

TECHNICAL ISSUE ---------- LOSS OF CONTROL ROD WORTH DUE TO DEPLETION

REQUIREMENTS

10 CFR Part 50 Appendix A, General Design Criterion (GDC) 10 requires the reactor design to include appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during normal operation or anticipated operational occurrences (AOOs). GDC 20, "Protection System Functions," requires automatic initiation of the reactivity control systems to assure that SAFDLs are not exceeded as a result of AOOs and that automatic operation of systems and components important to safety occurs under accident conditions. In addition, GDC 28, "Reactivity Limits," requires that the effects of postulated reactivity accidents neither result in damage to the reactor coolant pressure boundary greater than limited local yielding nor cause sufficient damage to impair significantly the capability to cool the core. All of these requirements involve accurate knowledge of the total and differential worths of the control element assembly (CEA).

In accordance to the review guidance provided to the staff in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," a reactor must maintain adequate control and shutdown margin. Specfically, the SRP states: "The adequacy of the control systems to assure that the reactor can be returned to and maintained in the cold shutdown condition at any time during operation. The applicant shall discuss shutdown margins (SDM). Shutdown margins need to be demonstrated by the applicant throughout the fuel cycle."

ISSUE

Based on the DCD, the APR1400 design includes two types of CEA, full strength and part strength CEAs. The full strength CEAs use B_4C as neutron absorber. On page 4.3-7, the DCD states: "Methods of controlling the power distribution include the use of full- or part-strength CEAs to alter the axial power distribution; decreasing CEA insertion by boration, thereby improving the radial power distribution; and correcting off-optimum conditions that cause margin degradations such as CEA misoperation." On page 4.3-17, the DCD also indicates: "The regulating CEA groups can be used to compensate for changes in reactivity associated with routine power level changes. In addition, they can be used to compensate for minor variations in moderator temperature and boron concentration during operation at power and to dampen axial xenon oscillations." On page 4.3-24, the DCD states: "Control action with part-strength rods or full-strength rods may be required to limit the magnitude of the oscillation." As such, some or all of the regulating rods may be inserted into the reactor in extended period of time and at various depths during power operations. Consequently, the full strength CEAs being used as regulating rods may lose their worth over time due to B-10 depletion. Consequently, the reactor may lose its ability to shutdown effectively and/or its safe shutdown margin.

In addition, the differential control rod worth curves may change over time for the CEAs that are used as regulating rods due to uneven axial depletion of B-10. Since regulating CEAs are inserted from the top of the core, they will gradually lose their worth from the bottom of the rods and the amount of loss varies depending on the location, depth, and duration of the insertion.

For the reasons discussed above, the staff is concerned with the potential loss of control rod worth of the CEAs that are used as regulating rods because the loss of control rod worth may hinder the system's ability to promptly and effectively shut down the reactor.

INFORMATION NEEDED

In its response to this RAI, the applicant is requested to provide an evaluation of:

1. the estimated CEA exposure as regulating rods and the bases for the estimate;
2. the corresponding loss of control rod worth because of B-10 depletion;
3. the changes in differential control rod worth, i.e., skewed control rod worth curve and revise Figures 4.2-14 and 4.3-6 to update the control rod differential curve and control rod worths if necessary;
4. the impact of loss of control rod worth on core shutdown time; and
5. the impact of change of control rod worth and differential control rod worth on the safety assessment of various relevant AOOs and accidents as specified in Chapter 15, "Transient Analyses" for the APR1400;and the need for updating the values of the setpoints in the core protection system, COLSS.

The applicant also needs to evaluate the impacts of loss of control rod worth and changes of differential control rod worth curve, if any, on all safety related analyses, including transient and accident analyses and revise the DCD and the associated technical reports as

necessary. This information is needed for the staff to determine the APR1400 design meets the regulatory requirements of GDC 10, GDC 11, GDC 20, and GDC 28.


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